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Determination Of The Carbon Footprint Based On The Life Cycle Analysis Agroindustrial Plants Agropecuarias Aliar

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ABSTRACT

The research was based on the Life Cycle Analysis of the production process in the agroindustrial plants of Agropecuaria Aliar S.A., to quantify carbon dioxide (CO_2) emissions. The ISO 14040 and 14044 methodologies were used to determine the carbon footprint.
Using the methodologies CML 2001, IPCC 2007, IPCC 2013 and ReCiPe Midpoint, it was found that between 2018 and 2019, emissions increased to 1.6622×10^9 kg CO_2 eq; being energy consumption the main generator of these impacts. It was identified that the main generator of atmospheric emissions is the electrical energy consumed in the treatment plants.

Keywords: Life Cycle Analysis, Greenhouse Gases, Carbon Footprint, kg CO2 equivalent, Environmental Impact.

1. INTRODUCTION

Greenhouse Gases (GHG) are gaseous components of the atmosphere, they are a natural part of the temperature balance of the planet, but due to the increase in the concentrations of these gases in the atmosphere, as a result of anthropogenic activities and commercial and industrial development, they have become a problem that fully encompasses the environmental context. Over the last few years, the concern about these gases and their effect on the planet has encouraged the search for control and mitigation alternatives to help solve the consequences that have arisen as a result of emissions. Also, the company Agropecuaria Aliar S.A., being the largest agro-industrial project in the country, generates a large amount of greenhouse gases in the activities it performs on a regular basis, causing possible damage to air quality at local and regional level. In order to find solutions to reduce the company's environmental problems, it is necessary to prioritize studies that identify the sources of emissions within the company. One way to do this is by using the "Life Cycle Analysis" (LCA), in order to identify the processes involved in each of the necessary stages in the production of a product. To achieve the objectives set out in this project, the methodology proposed by ISO 14040 and 14064 is applied to perform the Life Cycle Analysis of the processes carried out by the agroindustrial plants of Agropecuaria Aliar S.A., in order to measure the prevailing environmental impacts in the drying, soybean oil extraction and concentrate production processes.

2. METHODOLOGY

In accordance with ISO, International Organization for Standardization, a framework for the standardization of the LCA methodology was defined, according to the ISO 14.040 family of standards:
- UNE - ISO 14.040:2006: Environmental management. Life cycle analysis. Principles and reference framework.
- UNE - ISO 14.044:2006: Environmental management. Life cycle analysis. Requirements and guidelines.

Consequently, the methodology for the development of the project (Figure 1), is estimated according to four phases determined by NTC-ISO 14040, (2007), which will be described below:

Phase I. Definition of objectives and scope. The limits of the system are determined by factors such as available economic resources, availability and accuracy of information and the application of the study, among others. In addition, they can also be established geographically, temporally or with an exclusion of stages of the process.

Phase II. Life Cycle (LCI). This is the phase of the LCA in which the data corresponding to the inputs and outputs for all the processes of the product system are collected (NTC-ISO 14040, 2007). To carry it out, firstly, a flow diagram is made to identify the inputs and outputs of the system, and secondly, the primary and secondary sources of information are selected.

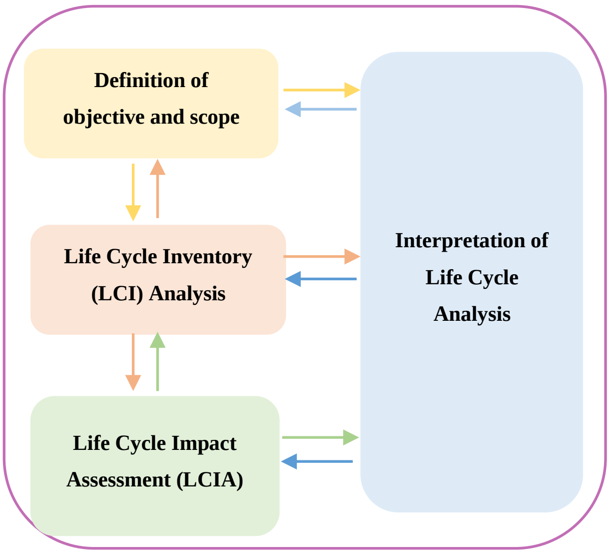

Figure 1. Terminology scope of an LCA. Source: ISO 14.040, 2006. Edited by: Author, 2020

Phase III. Impact Assessment (LCIA). This is the phase in which the inventory of inputs and outputs is converted into indicators of potential environmental impacts on the environment, human health and the availability of natural resources. The procedure is as follows: first the LCI data is classified into impact categories, followed by the characterization of each LCI substance with respect to the reference substance, and finally normalization, grouping and weighting, using the methodologies CML 2001, IPCC 2007, IPCC 2013 and ReCiPe Midpoint (H) with the Climate change indicator which is expressed in kg CO_2 equivalent.

Phase IV. Life Cycle Assessment Interpretation. Interpretation in a life cycle analysis is a systematic technique for identifying, quantifying, verifying and evaluating information from the LCI and LCIA impact assessment results and communicating them effectively.

3. RESULTS

The results and analysis obtained after performing the Life Cycle analysis of the agro-industrial plants located in the Fazenda nucleus of Agropecuaria Aliar S.A. are presented, and from this the carbon footprint was determined, the purpose of the latter is to establish the amount of CO_2 equivalent generated in the agro-industrial processes of the company.

Phase I. Definition of objectives and scope.
Objective. To develop the Life Cycle Assessment (LCA) to the agroindustrial plants of Agropecuaria Aliar S.A. using OpenLCA software to determine the amount of carbon dioxide equivalent (kg CO_2 eq).
Scope. The object of study are the 3 agroindustrial plants (drying, extractor and concentrate), which carry out the production process of concentrated feed for pigs. The function of the system under study is to adapt the incoming raw material (corn and soybean), to feed the pig farming area of the company after being processed. The functional unit is the "ton of concentrate" because it is a unit of mass that relates the final objective to a physical magnitude. The systems studied are the three agroindustrial plants, the drying plant, the soybean oil extraction plant and the concentrate plant, located in the Fazenda nucleus of Agropecuaria Aliar S.A. Each plant is made up of a set of equipment and unitary operations that are part of the treatment process. Geographical limits, the agroindustrial plants are located in the municipality of Puerto López, Meta, Colombia. Temporal limits, the data reported by the agroindustrial plants from January 2018 to December 2019, where 2018 will be taken as the base year and 2019 will be the year under study. System limits, the processes carried out in the agroindustrial plants were taken, unifying the 3 plants, with their respective inputs and outputs that occur per process.

Phase II. Inventory Development (ICV).
Table 1 shows the inventory of primary and secondary sources of agroindustrial plants.

Table 1. Inventory of primary and secondary sources of agroindustrial plants.

Materials	Unit	Unit Functional UF 2018	Unidad Funcional UF 2019	Agribalyse
Corn	ton/ton	0.310711	0.303991	Dried grain maize. FR
Soybeans	ton/ton	0.11267	0.10612	Soybean FR
Hexane	ton/ton	0.001153304	0.001031801	Hexane
LPG	ton/ton	0.000984632	0.000989337	Liquefied petroleum gas
Electricity consumption	Mwh/ton	54.26871204	53.26772798	Electricity. médium voltage. CO

Phase III. Impact Evaluation (ICAE).
Using the OpenLCA software, the analyzed results of the concentrated feed production process for the years 2018 and 2019 in the agroindustrial plants were obtained (see Table 2).

Table 2. Results of the environmental impact on agroindustrial plants, year 2018 and 2019.

Methodology-Indicator	Inputs	Impact per input (kgCO2 eq.), 2018	Global environmental global (kg CO2 eq.), 2018	Impact per input (kgCO2 eq.), 2019	Global environmental global (kg CO2 eq.), 2019
CML 2001 – Climate Change	Maíz	$1,48618x10^7$	$1,6113x10^9$	$1,5206x10^7$	$1,6534x10^9$
	Soya	$1,18793x10^7$		$1,170x10^7$	
	Hexano	-		-	
	GLP	$9,64077x10^4$		$1,0130x10^5$	
	Consumo eléctrico	$1,58447x10^9$		$1,6264x10^9$	
IPCC 2007 – Climate Change	Maíz	$1,48619x10^7$	$1,6113x10^9$	$1,5206x10^7$	$1,6534x10^9$
	Soya	$1,18775x10^7$		$1,1699x10^7$	
	Hexano	-		-	
	GLP	$9,64020x10^4$		$1,0129x10^5$	
	Consumo eléctrico	$1,58447x10^9$		$1,6264x10^9$	
IPCC 2013 – Climate Change	Maíz	$1,43509x10^7$	$1,6198x10^9$	$1,4683x10^7$	$1,6622x10^9$
	Soya				
	Hexano				

Methodology-Indicator	Inputs	Impact per input (kgCO2 eq.), 2018	Global environmental global (kg CO2 eq.), 2018	Impact per input (kgCO2 eq.), 2019	Global environmental global (kg CO2 eq.), 2019
	GLP	1,11046x10^7		1,0938x10^7	
	Consumo eléctrico	-		-	
		9,78145x10^4		1,0278x10^5	
		1,59425x10^9		1,6364x10^9	
ReCiPe Midpoint (H) – Climate Change	Maíz	1,48259x10^7	1,6102x10^9	1,5169x10^7	1,6522x10^9
	Soya	1,18396x10^7		1,1662x10^7	
	Hexano	-		-	
	GLP	9,62039x10^4		1,0109x10^5	
	Consumo eléctrico	1,58340x10^9		1,6253x10^9	

For the processes carried out in 2018 in the agroindustrial plants, the methodologies CML 2001, IPCC 2007, IPCC 2013 and ReCiPe Midpoint (H) were used, and based on the Climate Change GWP 100[a] indicator, the environmental impact of each of the system inputs was determined (Table 2); the methodologies CML 2001 and IPCC 2007 generated the same environmental impact results for each system input with a globalized impact value of 1.6113x10^9 kg CO_2 eq. The IPCC 2013 methodology presents the highest environmental impact result compared to the other methodologies with a value of 1.6198x10^9 kg CO_2 eq, and likewise the ReCiPe Midpoint (H) methodology has the lowest result of the analysis, 1.6102x10^9 kg CO_2 eq.
For the analysis of the processes carried out in 2019 in the agroindustrial plants, the methodologies CML 2001 and IPCC 2007 were used and generated the same environmental impact results for each input of the system with a globalized impact value of 1, 6534x10$_9$ kg CO^2 eq, the IPCC 2013 methodology presents the highest environmental impact result compared to the other methodologies with a value of 1.6622x109 kg CO_2 eq, and the ReCiPe Midpoint (H) methodology has the lowest result of the analysis, 1.6522x10^9 kg CO_2 eq.
None of the methodologies used has data on the generation of kg CO_2 eq, due to the use of hexane as an input product to the system process; therefore, an analysis of hexane was performed, determining the environmental impacts associated with this product, using the photochemical oxidation indicator of the CML 2001 methodology (see Table 3).

Tabla 3. Other results of environmental impact in agroindustrial plants, year 2018 and 2019.

Methodology-Indicator	**Inputs**	**Impact per input (kg formed ozone), 2018**	**Global environmental global (kg formed ozone), 2018**	**Impact per input (kg formed ozone), 2019**	**Global environmental global (kg formed ozone), 2019**
	Maíz	1242,87		1271,62	
	Soya	968,45		953,88	
	Hexano	$9,883x10^4$		$9,246x10^4$	$1,889x10^5$
	GLP		$1,928x10^5$		
	Power consumption	32,16		33,73	
		$9,172x10^4$		$9,414x10^4$	

From this, it is evident that the year of study with the highest generation of kg CO2 eq is 2019, due to the fact that there were higher inputs of raw materials and energy consumption. In each of the methodologies applied it is observed that the IPCC 2013 presents the highest peak of generation of environmental impacts in the process, the ReCiPe Midpoint (H) presented in both years the lowest values compared to the other methodologies and the kg ozone formed methodologies IPCC 2007 and CML 2001 gave results in which their values are minuscule.

4. CONCLUSIONES

The results obtained in the research present a degree of uncertainty, due to the fact that the inventory of emissions and the determination of environmental impacts generated, are extracted from an international database, which does not require national or regional information in Colombia, likewise the information provided by the Life Cycle Analysis through the methodology developed in the research, provides a starting point for the company, identifying the processes that generate significant atmospheric emissions and thus focus improvement actions in these processes.

In the agroindustrial plant processes, the environmental impacts caused locally and regionally, measured through the climate change indicators contained in the methodologies CML 2001, IPCC 2007, IPCC 2013 and ReCiPe Midpoint show that during 2018 approximately 1, $6198x10^9$ kg CO_2 eq to the atmosphere, and for 2019 these emissions increased to $1,6622x10^9$ kg CO_2 eq, with energy consumption being the main generator of environmental impacts, from these results Agropecuaria Aliar S. A. identifies that the main generator of atmospheric emissions is the electrical energy consumed in the plants, due to the processes associated with the generation of energy from fossil fuels.

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